IJIMR
INTERNATIONAL JOURNAL OF INNOVATIVE AND MULTIDISCIPLINARY RESEARCH

ISSN: 3116-5990 online / 3116-5982 print
Volume 1 Issue No. 4
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DOI: https://doi.org/10.66206/eduheart.ijimr.64

Extent of Mathematics Teachers' Technology Integration, Competence, and Effectiveness and Its Effects on Learners' Engagement

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ARTICLE INFO

Date Received: September 15, 2026

Date Reviewed: September 30, 2026

Date Accepted: October 30, 2026

Date Published:
November 30, 2026

KEYWORDS

extent of technology integration; technological competence; teaching effectiveness; learner engagement; learning action cell; Leyte

ABSTRACT

National investment in educational technology raises the question of how far it has changed mathematics teaching and whether the changes reach learners. This descriptive-correlational study measured the extent of mathematics teachers' technology integration, technological competence, and teaching effectiveness and examined their effects on the engagement of Grade 9 learners in Area 2 of the DepEd Schools Division of Leyte in School Year 2025–2026. Data from 114 teachers and 381 learners, selected through stratified random sampling, were gathered with four Likert scales of good to excellent reliability (α = .88 to .93) and analyzed through weighted means, chi-square, and Pearson correlation. Integration was extensive at substitution (*M* = 3.64) and augmentation (*M* = 3.47) but limited at modification (*M* = 2.73) and redefinition (*M* = 1.85). Competence was Very High for basic operations (*M* = 3.72), communication, productivity, and web resources, but lower for troubleshooting (*M* = 3.40) and content development (*M* = 3.18), with multimedia development the weakest skill (3.05). Effectiveness was High to Very High, led by relational expertise (*M* = 3.54). Learners were affectively engaged (*M* = 3.13) but less engaged behaviorally (*M* = 2.85) and cognitively (*M* = 2.51). Trainings, school, educational attainment, and position were associated with integration and competence. Integration correlated strongly with competence (*r* = .72), and engagement correlated with effectiveness (*r* = .63) and integration (*r* = .51). Technology use among the teachers is broad but shallow, and its association with engagement runs largely through teaching quality. An eight-month, ₱2,000,000 district-based Learning Action Cell targeting transformative integration, production-oriented competence, and cognitive engagement is proposed.

Introduction

The Department of Education has invested heavily in equipping schools and training teachers for digital instruction, through national plans that position technology and innovation as levers of quality (Department of Education, 2022a), a new curriculum framework (Department of Education, 2023), and continuing directives on ICT integration and professional development (Department of Education, 2025). In the Schools Division of Leyte, these priorities appear in a steady stream of division memoranda on digitalization and training (Schools Division of Leyte, 2025). What remains less clear is the extent to which this investment has changed mathematics teaching in practice, and whether the changes reach learners.

Three teacher attributes determine that extent. The first is how far technology integration has progressed, whether it merely substitutes for traditional tools or transforms what learners do,

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as described by the SAMR model (Hamilton et al., 2020). The second is teachers' technological competence across operational, productive, communicative, and creative skills (Chandra & Ali, 2024). The third is teaching effectiveness, the broader quality of instruction within which technology is used (Mendez & Lopez, 2023). Whether these attributes matter is ultimately judged by learners' engagement in its affective, behavioral, and cognitive forms (Fredricks et al., 2020).

This study measured the extent of mathematics teachers' technology integration, competence, and effectiveness and examined their effects on learners' engagement in Area 2 of the DepEd Schools Division of Leyte during School Year 2025–2026. It determined the profile of the teachers and learners; the extent of integration at each SAMR level; the level of competence in each skill domain, item by item; the level of effectiveness and engagement; the profile characteristics associated with integration and competence; and the relationships of the teacher variables with engagement. Since the design is correlational, "effects" refers to significant associations. The findings were used to design a district-based Learning Action Cell (LAC) in mathematics with a defined timeline and budget.

Literature Review

Extent of integration. Technology in mathematics instruction ranges from replacement to transformation. At substitution and augmentation, it improves efficiency and presentation; at modification and redefinition, it allows tasks to be redesigned for analysis, collaboration, and authentic problem-solving (Hamilton et al., 2020). Studies show that higher-level uses improve cognitive engagement and problem-solving (Drijvers, 2023), and that dynamic tools improve conceptual understanding and participation (Barana et al., 2022). In practice, however, integration in many systems remains at the lower levels because of limited training, infrastructure, and institutional support (Musasa et al., 2024). In the Philippines, integration has been associated with improved engagement and performance in secondary mathematics (Garcia et al., 2023).

Extent of competence. Technological competence includes basic computer operations; setup, maintenance, and troubleshooting; productivity software; web resource use; communication media; and content development (Setiyani et al., 2020). Under TPACK, these skills must be joined with pedagogical and content knowledge to produce effective instruction (Koehler et al., 2021). Filipino teachers generally have adequate basic skills but limited advanced competencies in content development and troubleshooting (Chandra & Ali, 2024), and teachers' competence predicts both their effectiveness and their learners' engagement (Li & Wang, 2024). Postgraduate study and career stage shape teachers' capacity to adopt innovations (Gomez & Albrecht, 2021; Harris & Davis, 2023), and the quality and continuity of training shape competence more than its quantity (Capistrano & Tamayo, 2025; Lim & Tondeur, 2020).

Effectiveness and engagement. Effective mathematics teaching combines clarity, content expertise, positive relationships, and a professional disposition (Mendez & Lopez, 2023; Uya, 2023). Adaptive teaching sustains engagement (Zhang et al., 2024), and engagement increases

when teachers mediate technology skillfully (Rahimi & Rezvani, 2023). Interactive digital environments support all three dimensions of engagement (Aldahmash & Alshahrani, 2022).

Framework and legal bases. The study was anchored on constructivism, TPACK, and student engagement theory, and drew on the Unified Theory of Acceptance and Use of Technology to explain how facilitating conditions shape teachers' adoption of technology (Venkatesh et al., 2021). The proposed LAC follows Constructive Alignment, which requires that activities and assessments serve intended outcomes (Biggs, 2021). The legal bases include the ISTE Standards for Educators (International Society for Technology in Education, 2020), the Excellence in Teacher Education Act (Republic Act No. 11713, 2022), the Department of Information and Communications Technology Act (Republic Act No. 10844, 2015), and DepEd Order No. 35, s. 2022, which establishes the LAC as a school-based continuing professional development strategy (Department of Education, 2022b).

Methodology

Design. A descriptive-correlational design was used to measure existing conditions and their relationships without manipulation (Creswell & Creswell, 2018; Fraenkel et al., 2019).

Respondents. The respondents were 114 mathematics teachers and 381 Grade 9 learners from Area 2 of the DepEd Schools Division of Leyte during School Year 2025–2026, selected through stratified random sampling. Teachers came from nine named national high schools, led by Leyte National High School (8 teachers) and Baybay City National High School (7 teachers), and from 64 teachers in other selected schools.

Instruments. The questionnaire comprised profile sheets and four four-point Likert scales: technology integration (20 items across the four SAMR levels; Hamilton et al., 2020), technological competence (30 items across six domains; Chandra & Ali, 2024; Li & Wang, 2024), teaching effectiveness (20 items across four dimensions; Uya, 2023), and learner engagement (15 items across three dimensions; Fredricks et al., 2020). The constructs were rated as perceived by the respondent groups. A pilot test with 15 teachers and 15 learners from Area I yielded Cronbach's alpha values of .89, .92, .90, and .88, respectively, and .93 for the whole instrument (Taber, 2018).

Data collection. Following approval from the Graduate School and the Schools Division Superintendent, the researchers met school heads, administrators, and mathematics teachers to explain the study and the respondents' rights. Questionnaires were administered in person or online, collected, and checked for completeness. Teachers' teaching loads, unstable internet in some schools, and learners' involvement in other activities delayed some responses; these were resolved through flexible deadlines and follow-up visits.

Data analysis. Frequencies and percentages described the profiles, and weighted means described each indicator and dimension. The composite scores had skewness from −.098 to .213 and kurtosis from −.324 to .309, within the ±2 criterion for normality (George & Mallery, 2019). Chi-square tests were used for profile relationships and Pearson's r for relationships among the constructs, at $\alpha = .05$.

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Ethical considerations. The Schools Division Superintendent granted permission, all respondents gave informed consent, and participation was voluntary. Names were replaced with codes, data were kept on password-protected devices, and all handling followed the Data Privacy Act of 2012.

Results and Discussion

Profile of the Teachers and Learners

Table 1

Professional Profile of the Mathematics Teachers (n = 114)

Variable	Category	f	%
Educational attainment	Bachelor's degree	18	15.8
	Bachelor's degree with master's units	48	42.1
	Master's degree	39	34.2
	Master's with doctoral units or doctorate	9	7.9
Position	Teacher I	35	30.7
	Teacher II	45	39.5
	Teacher III	28	24.6
	Master Teacher I–IV	6	5.3
Years in teaching	1–5 years	25	21.9
	6–10 years	29	25.4
	11–15 years	32	28.1
	16 years and above	28	24.5
Relevant trainings	1–3	41	36.0
	4–6	39	34.2
	7–10	22	19.3
	More than 10	12	10.5

The teachers' professional profile shows a workforce that is academically prepared but not yet at senior levels (Table 1). More than four in five (84.2%) had at least master's units, yet only 5.3% were Master Teachers, and Teacher I to III positions accounted for 94.8%. Experience was evenly distributed, with the largest group at 11 to 15 years (28.1%). Most teachers had attended between one and six relevant trainings (70.2%), and only 10.5% had attended more than ten. Personally, the teachers were mostly 31 to 50 years old (63.1%), female (59.6%), and married (68.4%). The learners were mainly 14 to 15 years old (71.9%), nearly balanced by sex (51.7% female), and largely from households earning below ₱20,000 a month (58.2%).

This profile suggests a strong base for professional learning. Teachers with graduate training have the pedagogical reasoning to adapt technology to learning goals (Gomez & Albrecht, 2021), and mid-career teachers are especially receptive to collaborative, job-embedded learning (Harris & Davis, 2023). The small number of Master Teachers means mentoring capacity is limited and should be used strategically, while the modest number of trainings for

most teachers indicates that exposure to professional development has been broad but shallow (Capistrano & Tamayo, 2025; Palomar et al., 2025).

Extent of Technology Integration

Technology integration was Very High at substitution (*M* = 3.64) and High at augmentation (*M* = 3.47), then dropped to Moderate at modification (*M* = 2.73) and Very Low at redefinition (*M* = 1.85). The most widespread practices were digital notes and slides (3.91), projectors used as chalkboards (3.85), and graphing calculators for visualization (3.82). The least used were global data-sharing investigations (1.65), learner-designed interactive math games (1.75), and long-term computational modeling (1.85). Among modification practices, GeoGebra (2.95) and simulations (2.85) were used occasionally, and learner screencasts (2.40) rarely.

The extent of integration is therefore wide but shallow. Teachers have adopted technology broadly for presentation and calculation but have not yet used it to change learners' tasks. Substitution and augmentation are useful, but they do not by themselves produce the analysis, collaboration, and creation associated with deeper learning (Hamilton et al., 2020; Drijvers, 2023). This finding mirrors the contextual barriers reported in other systems (Musasa et al., 2024) and the observation that Philippine teachers frequently underuse available technology when they lack application-focused support (Cortez et al., 2024).

Extent of Technological Competence

Table 2

Technological Competence of the Mathematics Teachers per Indicator

Domain and Indicator	Mean	Level
Basic computer operations	**3.72**	**Very High**
Starts up, shuts down, and restarts systems	3.92	Very High
Applies basic keyboard shortcuts	3.85	Very High
Manages files and folders	3.78	Very High
Adjusts basic system settings	3.62	Very High
Installs, launches, and uninstalls software	3.45	High
Setup, maintenance, and troubleshooting	**3.40**	**High**
Accesses technical support resources	3.68	Very High
Sets up classroom hardware	3.55	Very High
Implements basic security practices	3.42	High
Performs basic maintenance tasks	3.25	High
Troubleshoots common problems	3.10	High
Word processing, spreadsheets, and presentation	**3.51**	**Very High**
Creates professional documents	3.88	Very High
Designs and delivers presentations	3.72	Very High
Uses spreadsheets for grades and charts	3.45	High
Collaborates on shared documents	3.35	High
Uses advanced formatting features	3.15	High
Web resources use and management	**3.50**	**Very High**
Uses search engines effectively	3.82	Very High
Downloads and saves web files	3.68	Very High

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Domain and Indicator	Mean	Level
Evaluates the credibility of online information	3.45	High
Adheres to copyright and fair use	3.32	High
Bookmarks and organizes web resources	3.25	High
Communication media skills	**3.53**	**Very High**
Uses professional email	3.85	Very High
Practices digital etiquette	3.68	Very High
Uses educational communication platforms	3.55	Very High
Facilitates video conferencing	3.42	High
Engages in professional networks	3.15	High
Content development and management	**3.18**	**High**
Creates or modifies digital materials	3.35	High
Uses learning management systems	3.22	High
Uses digital assessment tools	3.18	High
Organizes digital resource repositories	3.12	High
Develops multimedia content	3.05	High

Note. 3.50–4.00 = Very High; 3.00–3.49 = High; 2.50–2.99 = Moderate; 2.00–2.49 = Low; 1.00–1.99 = Very Low.

Competence was Very High in four of the six domains (Table 2). Basic operations was the strongest (*M* = 3.72), with starting up and restarting systems (3.92) and keyboard shortcuts (3.85) near the maximum. Communication media (*M* = 3.53), productivity software (*M* = 3.51), and web resources (*M* = 3.50) followed, led by professional email (3.85), document creation (3.88), and search engine use (3.82). Setup and troubleshooting (*M* = 3.40) and content development (*M* = 3.18) were High but lower. The six weakest indicators were developing multimedia content (3.05), troubleshooting common problems (3.10), organizing digital resource repositories (3.12), engaging in professional networks (3.15), using advanced formatting (3.15), and using digital assessment tools (3.18).

The pattern separates consumption from production. Teachers are highly competent at operating devices, finding and downloading resources, and communicating, but less competent at producing digital materials, managing repositories, assessing digitally, and fixing problems on their own. These production skills are the ones that modification and redefinition demand, so the competence profile helps explain the integration profile (Chandra & Ali, 2024; Setiyani et al., 2020). Low troubleshooting confidence can also discourage regular use, because teachers who must wait for outside help when equipment fails may avoid complex tools altogether (Cortez et al., 2024; Anudin, 2024). This consumption-heavy profile resembles that found when the skills and competencies of basic education teachers on Samar Island were mapped (Panela, 2025d).

Extent of Teaching Effectiveness and Learner Engagement

Table 3

Teaching Effectiveness and Learner Engagement by Dimension

Construct	Dimension	Mean	Level
Teaching effectiveness	Teaching-related behavior	3.44	High
	Subject matter expertise	3.49	High
	Relational expertise	3.54	Very High
	Personality	3.49	High
Learner engagement	Affective	3.13	High
	Behavioral	2.85	Moderate
	Cognitive	2.51	Moderate

Note. 3.50–4.00 = Very High; 3.00–3.49 = High; 2.50–2.99 = Moderate; 2.00–2.49 = Low; 1.00–1.99 = Very Low.

Teaching effectiveness was High to Very High, with relational expertise the strongest (M = 3.54) and teaching-related behavior the lowest (M = 3.44) (Table 3). The highest indicators were respect for all students (3.82), clear and organized presentation (3.72), current and accurate information (3.72), and consistency in conduct and grading (3.72), while real-world connections (3.05), adaptability (3.15), and timely feedback (3.18) were weakest. Learner engagement was High in the affective dimension (M = 3.13), Moderate in the behavioral dimension (M = 2.85), and weakest in the cognitive dimension (M = 2.51), where self-regulation (2.25) and deep learning (2.35) were Low.

Teachers are therefore strong in the traditional foundations of good teaching: clear presentation, accurate content, fairness, and respect. These strengths account for the learners' positive feelings toward their teachers (Uya, 2023). The weaker practices, connecting mathematics to real life, adapting to the unexpected, and giving timely feedback, are those most associated with cognitive engagement and those that higher-level technology integration can strengthen (Zhang et al., 2024; Mendez & Lopez, 2023). Learners' low cognitive engagement, and especially their limited self-regulation, indicates that these gaps reach the learners (Fredricks et al., 2020; Zimmerman & Schunk, 2022). Their circumstances also matter: many learners in this cohort experienced disrupted schooling during the pandemic, which affected students' mental health and learning routines (Panela, 2025c).

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Teacher Characteristics Associated With Integration and Competence

Table 4

Chi-Square Tests of Teachers' Profile Against Technology Integration and Competence

Profile Variable	Integration χ^2 (p)	Interpretation	Competence χ^2 (p)	Interpretation
Age	15.24 (.018)*	Significant	11.38 (.044)*	Significant
Sex	2.85 (.241)	Not significant	2.15 (.341)	Not significant
Civil status	6.03 (.197)	Not significant	5.67 (.225)	Not significant
Highest educational attainment	25.17 (< .001)*	Significant	28.93 (< .001)*	Significant
Position	19.45 (.002)*	Significant	24.16 (< .001)*	Significant
Years in teaching	13.88 (.031)*	Significant	10.95 (.027)*	Significant
School	31.29 (< .001)*	Significant	22.47 (< .001)*	Significant
Number of trainings attended	42.56 (< .001)*	Significant	51.32 (< .001)*	Significant

Note. *p < .05.

Six of the eight teacher characteristics were significantly associated with both integration and competence (Table 4). Number of trainings attended had the largest chi-square values (42.56 for integration and 51.32 for competence), followed by school (31.29 and 22.47), educational attainment (25.17 and 28.93), and position (19.45 and 24.16), all at $p \leq .002$. Age and years in teaching were significant but weaker (p = .018 to .044). Sex and civil status were not significant.

The extent of integration and competence thus follows teachers' professional opportunities rather than their personal characteristics. Training is the strongest correlate, which supports investment in professional development, but the school association indicates that training produces results only where school conditions, including leadership, resources, and collegial culture, allow teachers to apply it (Cortez et al., 2024; Lim & Tondeur, 2020). This is consistent with UTAUT's emphasis on facilitating conditions (Venkatesh et al., 2021). The associations with educational attainment and position support drawing on graduate-trained teachers and Master Teachers as mentors (Gomez & Albrecht, 2021; Harris & Davis, 2023). The lack of association with sex suggests that men and women teachers have similar access to technology-related growth; future comparisons of teacher self-ratings by sex would be strengthened by evidence that the scales function equivalently across genders, as tested in a Rasch analysis of a teacher empowerment scale (Panela, 2025a). On the learners' side, engagement was associated with family income (χ^2 = 31.47), school (χ^2 = 23.94), and both parents' education and occupation, but not with age or sex.

Effects on Learners' Engagement

All reported correlations were positive and significant at p < .001. Integration was strongly correlated with competence (r = .72) and moderately with effectiveness (r = .58) and engagement (r = .51). Effectiveness had the strongest correlation with engagement (r = .63), and competence was moderately correlated with effectiveness (r = .45). The correlation between competence and engagement was not reported in the manuscript.

In terms of effects, the extent of integration and the level of effectiveness both move with learners' engagement, and effectiveness does so more strongly. The likely route is that competence widens what teachers can do with technology, technology improves aspects of teaching such as visualization, feedback, and interaction, and better teaching engages learners (Koehler et al., 2021; Li & Wang, 2024; Rahimi & Rezvani, 2023). Expanding the extent of integration without improving teaching quality is unlikely to raise engagement much. These relationships are correlational, so they establish co-occurrence rather than effect in the causal sense, and a regression or mediation model would be needed to estimate the unique contribution of each teacher variable.

The District-Based Learning Action Cell

Table 5

Components of the Proposed District-Based Learning Action Cell in Mathematics

Area of Concern	Strategy	Timeline	Budget (₱)
LAC institutionalization	Division memorandum; formation of LAC clusters	Month 1	200,000
Technology integration	Workshops on task redesign and authentic digital tasks	Months 2–3	350,000
Technological competence	Hands-on training in multimedia creation, digital assessment, and data tools	Months 3–4	300,000
Pedagogical effectiveness	Lesson study and model teaching on feedback and real-world connections	Months 4–5	250,000
Mentoring and peer coaching	Cross-school mentoring pairs and coaching cycles	Months 5–6	220,000
Learner cognitive engagement	Design of inquiry-based, technology-enhanced mathematics tasks	Months 6–7	280,000
Equity and access	Resource-sharing hubs and mobile ICT support	Months 7–8	200,000
Monitoring and evaluation	Classroom observation, engagement surveys, performance analysis	Ongoing	200,000
Total		**8 months**	**2,000,000**

Each component of the LAC responds to a specific finding (Table 5). Institutionalization through a division memorandum and cross-school clusters addresses the strong school association and follows DepEd's LAC policy (Department of Education, 2022b). Workshops on task redesign target the drop from augmentation to modification and redefinition, and hands-on training targets the weakest competencies: multimedia creation, digital assessment, repositories, and troubleshooting. Lesson study on feedback and real-world connections addresses the weakest effectiveness indicators, and inquiry-based task design addresses learners' low cognitive engagement. Mentoring pairs make use of the graduate-trained teachers and Master Teachers in the workforce, and resource hubs respond to the unequal conditions across schools and families. Monitoring should judge the LAC by changes in classroom practice and learners' cognitive engagement rather than by attendance (Biggs, 2021). Teachers' experiences of building research capacity during the pandemic suggest that the LAC will

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succeed only if it reduces barriers such as workload and lack of mentoring rather than adding to them (Panela, 2025e).

Conclusion

The extent of technology integration among mathematics teachers in Area 2 of the Schools Division of Leyte is broad at the substitution and augmentation levels but limited at modification and very limited at redefinition. Teachers' technological competence is Very High for operating, communicating, and using existing resources but lower for producing digital content, managing repositories, assessing digitally, and troubleshooting. Teaching effectiveness is high, particularly in relationships and content accuracy, but weaker in real-world connections, adaptability, and feedback. Learners are affectively engaged, moderately engaged in behavior, and least engaged cognitively. Training, school, educational attainment, and position are associated with integration and competence. Integration, competence, and effectiveness are positively related, and effectiveness and integration are significantly related to learners' engagement, effectiveness more strongly.

The division should institutionalize the proposed eight-month, ₱2,000,000 district-based LAC in mathematics and use it to deepen rather than broaden technology use: redesigning tasks at the modification and redefinition levels, building production-oriented competencies, strengthening feedback and real-world connections, and designing inquiry-based tasks for cognitive engagement. Mentoring across schools, shared resources for less-resourced schools, and monitoring centered on cognitive engagement should accompany these efforts. Because the LAC adds to teachers' responsibilities, their well-being deserves attention; one recent study reported that teachers used a digital companion tool to manage workplace stress (Panela, 2026). Schools should also remain attentive to learners' mental health as they re-engage in demanding mathematical work after years of disruption (Panela, 2025b). Future studies should estimate the effects of the teacher variables with regression and should obtain learners' and teachers' ratings separately.

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